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Polarization characteristics of zebra pattern in type IV solar radio bursts observed with AMATERAS

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Type IV bursts are broadband continuum emission observed in metric to decimetric wavelength range that emanate from closed magnetic structures. They often show various spectral fine structures therein. Since most of them are considered to be generated by micro scale physical processes of plasma waves and energetic particles, their spectral characteristics reflect plasma condition of the source regions in the solar corona. In particular, zebra pattern (ZP) has a characteristic spectral pattern with a number of nearly parallel drifting narrowband stripes. Such characteristics of ZP can be used as a tool of the coronal plasma diagnostics, thus the comprehension of ZP has significant meaning for the solar physics. However, generation processes of ZP have been still discussed in spite of a large number of observational and theoretical studies. The purpose of this study is to investigate generation and propagation processes of ZP by evaluating scenarios suggested in previous studies (Zlotnik et al., 2014).

We analyzed an event appeared on June 21, 2011 around 200MHz, in particular on polarization characteristics and their frequency dependences using highly resolved spectra and polarization data obtained from AMATERAS, a solar radio spectropolarimeter developed by Tohoku University. The main observed polarization characteristics are, 1) the ZP emission accommodated right-handed and left-handed polarized components and the degree of circular polarization was about 50-70% in right-handed with almost no frequency dependence. 2) The frequency of right-handed and left-handed polarized components showed a slight difference by tens of kHz and it varied depending on the emission frequency. 3) The light-handed polarized component showed time delay by about 60ms and the delay slightly increased with frequency. In the case of assuming the DPR (Double Plasma Resonance) model as the original generation process of the ZP, the most plausible interpretations for these characteristics are as follows; the emission was generated in O-mode in completely polarized state at the source region and it was partly converted into X-mode near the source due to the scattering by low frequency waves such as ion sound waves or whistler mode waves, which yields the frequency shift, and then difference in group velocities between O-mode and X-mode causes the temporal delay.

Keywords: Solar radio, Zebra pattern, Polarization, AMATERAS